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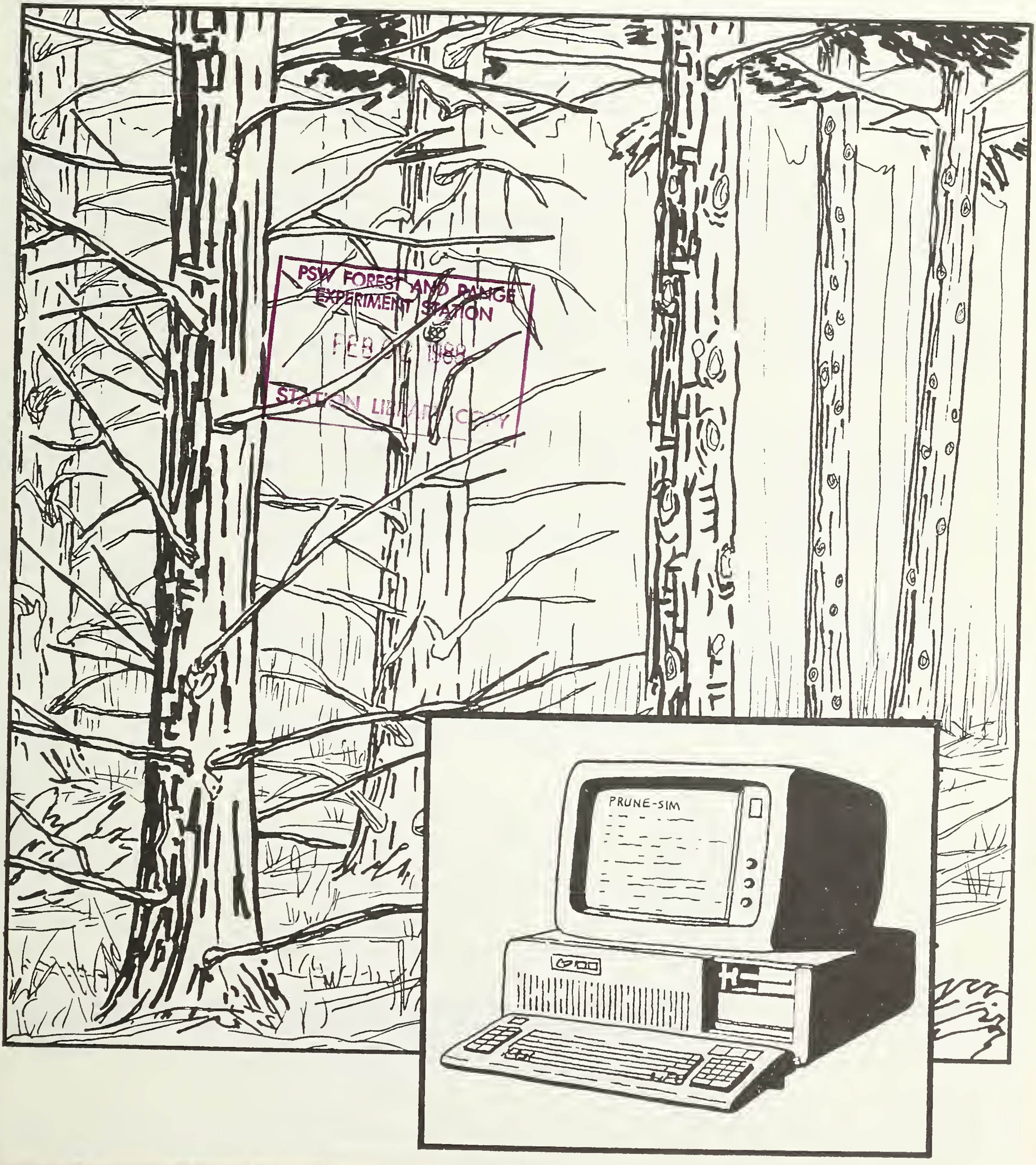
Financial Analysis of Pruning Coast Douglas-Fir

Roger D. Fight, James M. Cahill, Thomas D. Fahey, and Thomas A. Snellgrove



Authors

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Abstract

Fight, Roger D.; Cahill, James M.; Fahey, Thomas D.; Snellgrove, Thomas A. 1987. Financial analysis of pruning coast Douglas-fir. Res. Pap. PNW-RP-390. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 17 p.

Pruning of coast Douglas-fir was evaluated; recent product recovery information for pruned and unpruned logs for both sawn and peeled products was used. Dimensions of pruned and unpruned trees were simulated with the Douglas-fir stand simulator (DFSIM). Results are presented for a range of sites, ages at time of pruning, ages at time of harvest, product prices, and interest rates, and for both fertilized and unfertilized regimes.

Summary

Unpruned stands of young-growth Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco var. *menziesii*) yield little clear material with the kinds of regimes now being commonly implemented in western Oregon and western Washington. A recent recovery study provides the basis for comparing the grade recovery from the butt logs of pruned trees with that of unpruned trees (Cahill and others, in press). A spreadsheet program was developed and used to simulate the increase in grade recovery and financial return from pruning. The analysis of financial return was done with DFSIM growth and yield data reported by Curtis and others (1982). The analysis included a range of sites, ages at time of pruning, ages at time of harvest, prices, and interest rates, and both fertilized and unfertilized regimes.

Results showed that a 5-year difference in the time of pruning can make a substantial difference in the financial return. The earlier age at pruning always gave a higher return. The number of years between pruning and harvest that gives the highest return from pruning depends on the site, the interest rate, and whether or not the stand is fertilized. At a 4-percent interest rate, the return was generally highest when the harvest was 40 to 50 years after pruning. At an 8-percent interest rate, the return was generally highest when the harvest was 30 to 40 years after pruning.

The financial return from pruning stands on an unfertilized site 145 (50-year site index) was roughly twice that from an unfertilized site 85. Fertilization substantially increases the return from pruning, especially on low sites. The return from pruning stands on a fertilized site 85 is almost as high as that from an unfertilized site 125.

Keywords: Simulation, pruning, Douglas-fir (coast), product recovery, financial analysis, forest product value.

Contents

Introduction

Although several evaluations have been made of pruning coast Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco var. *menziesii*) over the years (Dimock and Haskell 1962, Dobie and Wright 1978, Fensom 1957, McBride 1961, Shaw and Staebler 1950), pruning has not been adopted as an operational practice on any significant area in the Pacific Northwest. The financial return from pruning comes from the increase in value of clear wood that will be produced from pruned trees. Given the short harvest cycles used in current management of Douglas-fir and its limb-retention characteristics, little clear wood will be produced in unpruned young-growth stands. The crucial question is whether the increase in value from additional clear wood will justify the investment in pruning. The purpose of this paper is to provide the results of financial evaluations of pruning managed stands of Douglas-fir across a range of sites, management regimes, prices, and interest rates. These evaluations are based on a new study of product grade recovery from pruned Douglas-fir (Cahill and others, in press). A spreadsheet template, PRUNE-SIM (Fight and others 1987), which works on a personal computer with Lotus 1-2-3 spreadsheet software, was used in the analysis.[1] This template can be used to do further sensitivity analysis, to look at other regimes, or to otherwise customize the results to a particular owner, agency, or geographic area.

Specific questions about financial return from pruning are addressed:

1. What is the best age for pruning coast Douglas-fir?
2. What is the best interval between pruning and harvest?
3. How does site productivity affect financial return?
4. How does fertilization affect financial return?
5. How do wood product prices affect financial return?

The financial returns reported in this paper are the present values of the increases in product value resulting from pruning. This financial return is the maximum amount that can be spent for pruning without reducing the rate of return on investment below the specified rate. No pruning costs are reported. The user must provide information on the cost of pruning to determine the present net value of pruning (present value net of pruning cost).

First, we discuss the assumptions and limitations of the analysis that are needed to evaluate the results and conclusions. We then present a series of graphs that result from many simulations. Lastly, we show graphs that address the five questions above.

Assumptions

Yield Data

All the evaluations in this report are based on regimes reported in the published Douglas-fir simulator (DFSIM) yield tables (Curtis and others 1982). These regimes use the DFSIM default thinnings. Some regimes include fertilization. We use these regimes to obtain simulated tree descriptions needed for estimating log volumes. This analysis is based on pruning a 17-foot butt log above a 1-foot stump. This assumption is imposed by the recovery study, in which all the pruned trees had been pruned to yield a 17-foot clear log. Pruning is assumed to have no impact on tree growth, so the volume with and without pruning is the same. According to the literature (Staebler

[1] The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture of any product or service to the exclusion of others that may be suitable.

1963, Stein 1955), pruning has little effect on tree growth if less than one-third of the live crown is removed. Another assumption is that 5 percent of the pruned trees are lost before final harvest; this assumption is a guess. Poor selection of trees for pruning, careless selection of trees for logging, and careless logging could result in much higher losses of pruned trees. The mortality in stands included in the regimes used here ranges from about 6 to 10 percent.

Log and Tree Dimensions

Log diameters are determined from a tree profile equation described in the PRUNE-SIM users guide (Fight and others 1987). For this analysis, we assumed that the number of pruned trees would not exceed the number of trees that could be carried to harvest age so that all the pruned trees were harvested at the final harvest. We also assumed that the largest trees in the stand would be selected for pruning. All regimes began with 300 trees per acre, but the number of pruned trees was 60, 80, or 100, depending on how many could be carried to final harvest. Because the pruned trees are one-fifth to one-third of the stand, we used the DFSIM reported height of the 40 tallest trees (HT40) rather than the height of the tree of average volume (Lorey height) to represent the height of the pruned trees at time of pruning. At time of harvest, almost all the trees are pruned trees, so we used Lorey height rather than HT40. The diameter of the pruned trees at time of pruning was estimated by determining the median diameter of the pruned trees; a normal distribution of tree diameters was assumed. The procedure is described in the PRUNE-SIM users guide (Fight and others 1987). At time of harvest, the stand diameter reported in DFSIM is used without modification (Curtis and others 1982).

Price Assumptions

The analysis included two sets of price assumptions. The "low" assumption is based on 1986 prices (Random Lengths 1987, Warren 1987). We regard this as a very conservative assumption for this analysis; prices in 1986 were substantially below the long-term trend in product prices, and preliminary projections from the southern timber supply study[2] indicate that prices should increase substantially above the 1986 level over the next several decades. Our "high" price assumption is based on those projections for the year 2030. The following tabulation shows the prices:

	Low price	High price
	(Dollars per thousand board feet)	
Lumber:		
Select	566	820
Select Structural	240	447
Standard and Better	191	338
Utility and Economy	111	198
	(Dollars per thousand square feet, 3/8-inch basis)	
Veneer:		
A and B	180	324
C and D	90	162

Veneer prices are for green veneer and are quoted per thousand square feet on a finished panel size.

[2] Preliminary data from the southern timber supply study on file with Richard Haynes, Economist, USDA Forest Service, Forestry Sciences Laboratory, P.O. Box 3890, Portland, OR 97208.

Other Key Assumptions

In our analysis, we assumed no differences in costs in stand management, logging, or manufacturing after pruning, except in veneer manufacturing, for which we assumed that the AB veneer from pruned logs would be produced at a cost saving of $88 per thousand square feet (3/8-inch basis) of 1/10-inch veneer. This saving results from a dramatic reduction in the number of patches required.

Another key assumption of this analysis is that the future unpruned trees will be like the unpruned (control) trees in the recovery study (Cahill and others, in press). The control stands were more heavily stocked and had more thinnings than is likely in the future. This resulted in a bias against pruning because these control trees probably had smaller limbs than if they had been grown under lighter stocking and with fewer entries. Another bias in our results against pruning for lumber resulted from the recovery's being based on a production-oriented sawmill. A greater difference in value between the pruned and unpruned logs would be achieved in a mill oriented to sawing for grade, although this would be partially offset by higher manufacturing costs.

Results

Figures 1 to 11 show the maximum amount per tree that could be spent to prune the butt logs without reducing the rate of return below the specified rate. The difference between this value and the estimated cost of pruning (supplied by the user) is net present value from pruning. Each graph shows the results for three interest rates: 4, 6, and 8 percent. Each graph shows the present value for one product (lumber or veneer), one price assumption (high or low), one King's (1966) 50-year site index class (85, 105, 125, or 145), one age at time of pruning, and a series of ages at harvest. Each figure has a series of graphs that show the results for various regimes for one product and one price assumption. Figure 1 shows the present value from pruning for lumber under the high price assumption; figure 2, under the low price assumption. Figures 3 and 4 give the same information for veneer. Figures 5-8 show a series of regimes that include two or three fertilizations with 200 pounds of nitrogen, depending on whether the age at harvest permits the third application of fertilizer. Figure 5 is for lumber under the high price assumption and figure 6 under the low. Figures 7 and 8 give the same information for veneer.

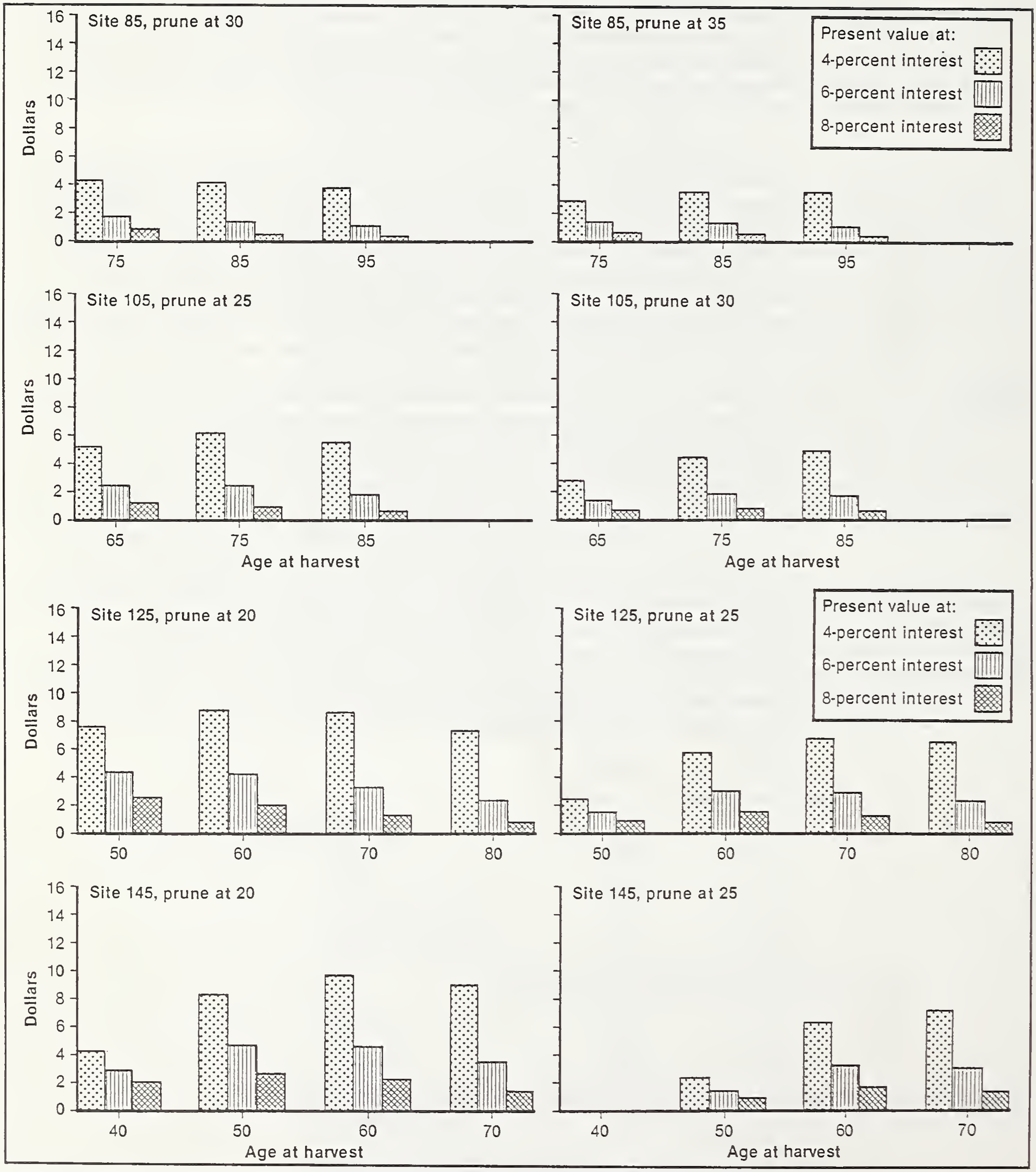

Figure 1—Increase in present value per tree from pruning unfertilized stands for lumber with the high price assumption.

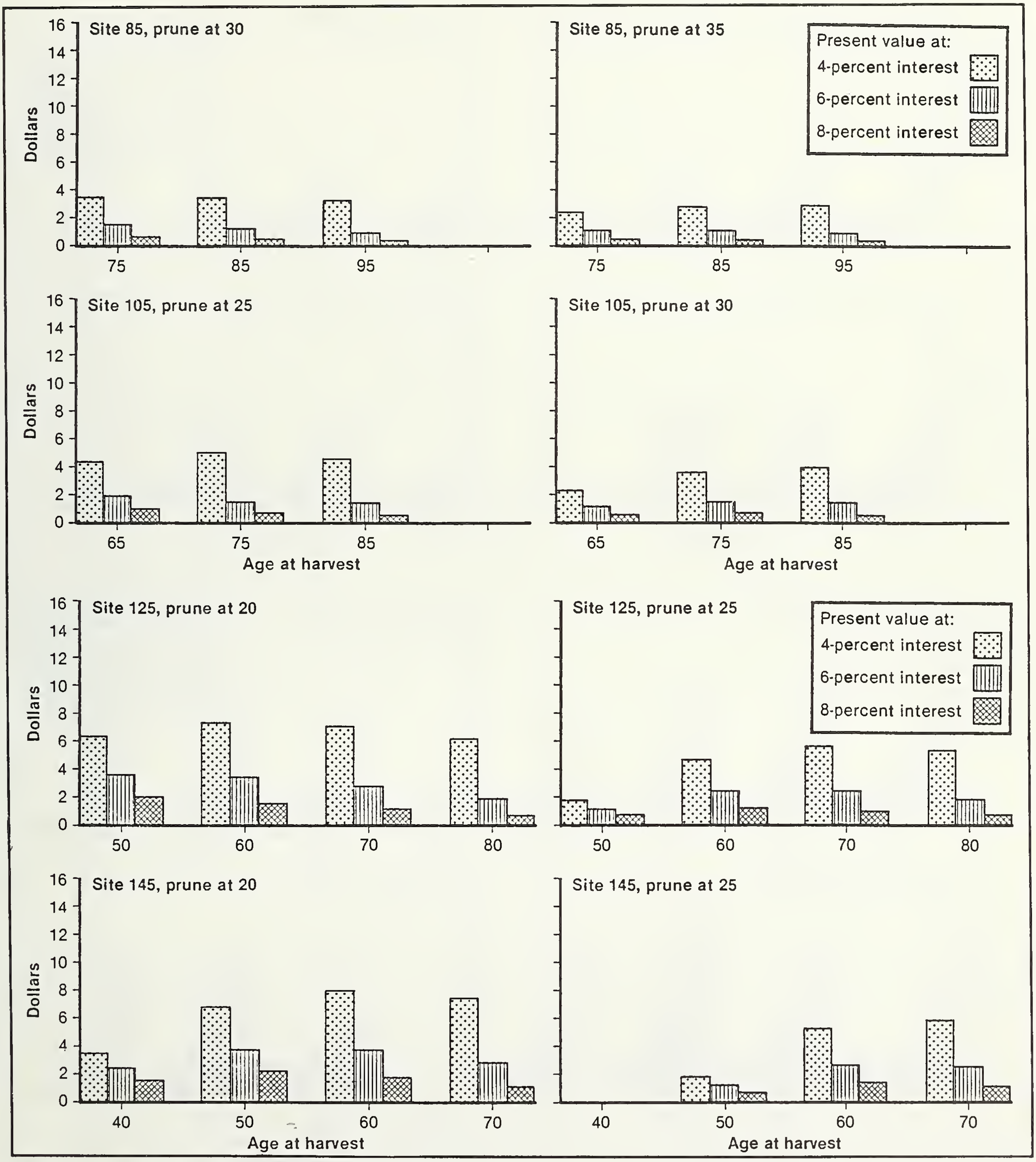

Figure 2—Increase in present value per tree from pruning unfertilized stands for lumber with the low price assumption.

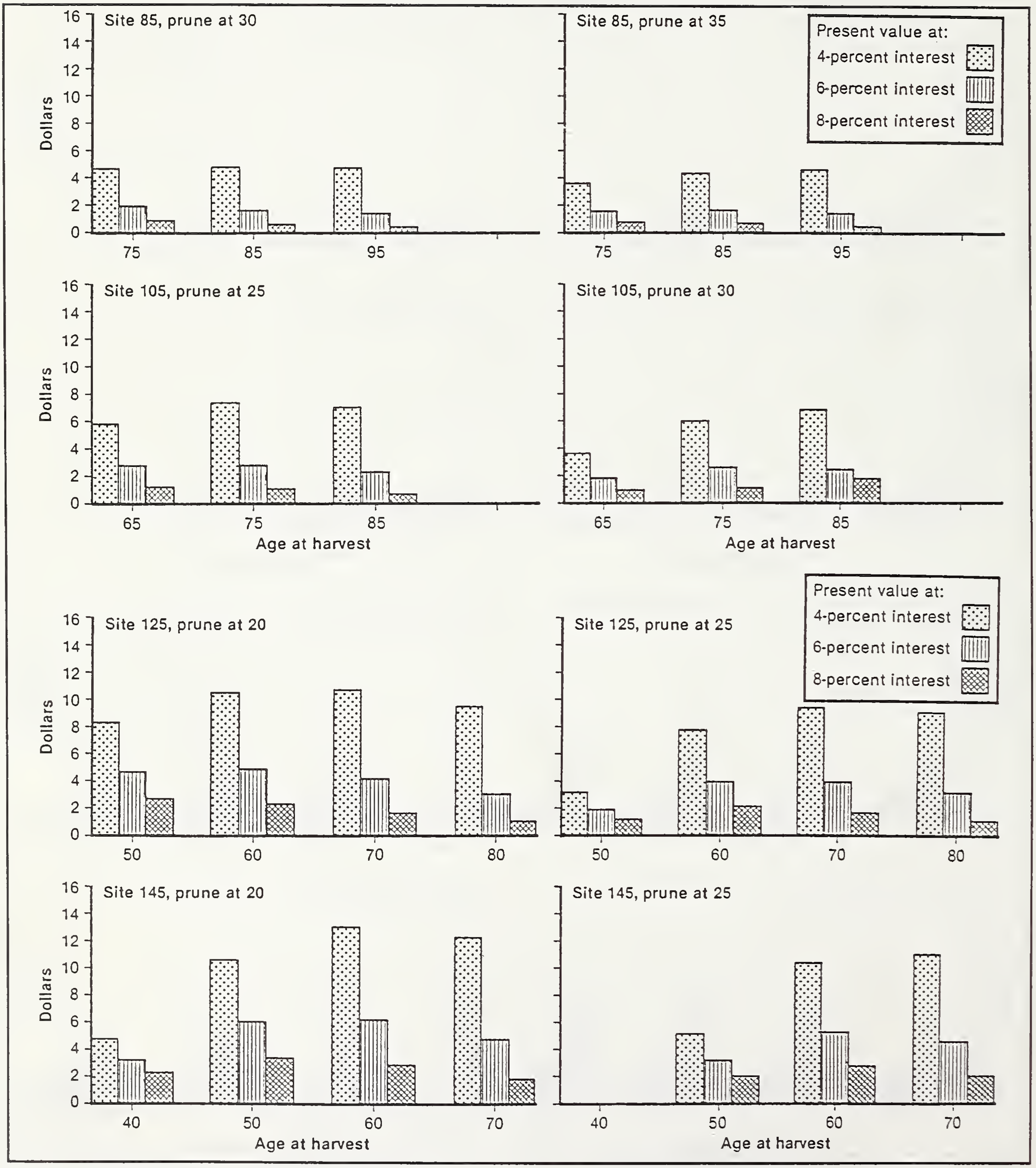

Figure 3—Increase in present value per tree from pruning unfertilized stands for veneer with the high price assumption.

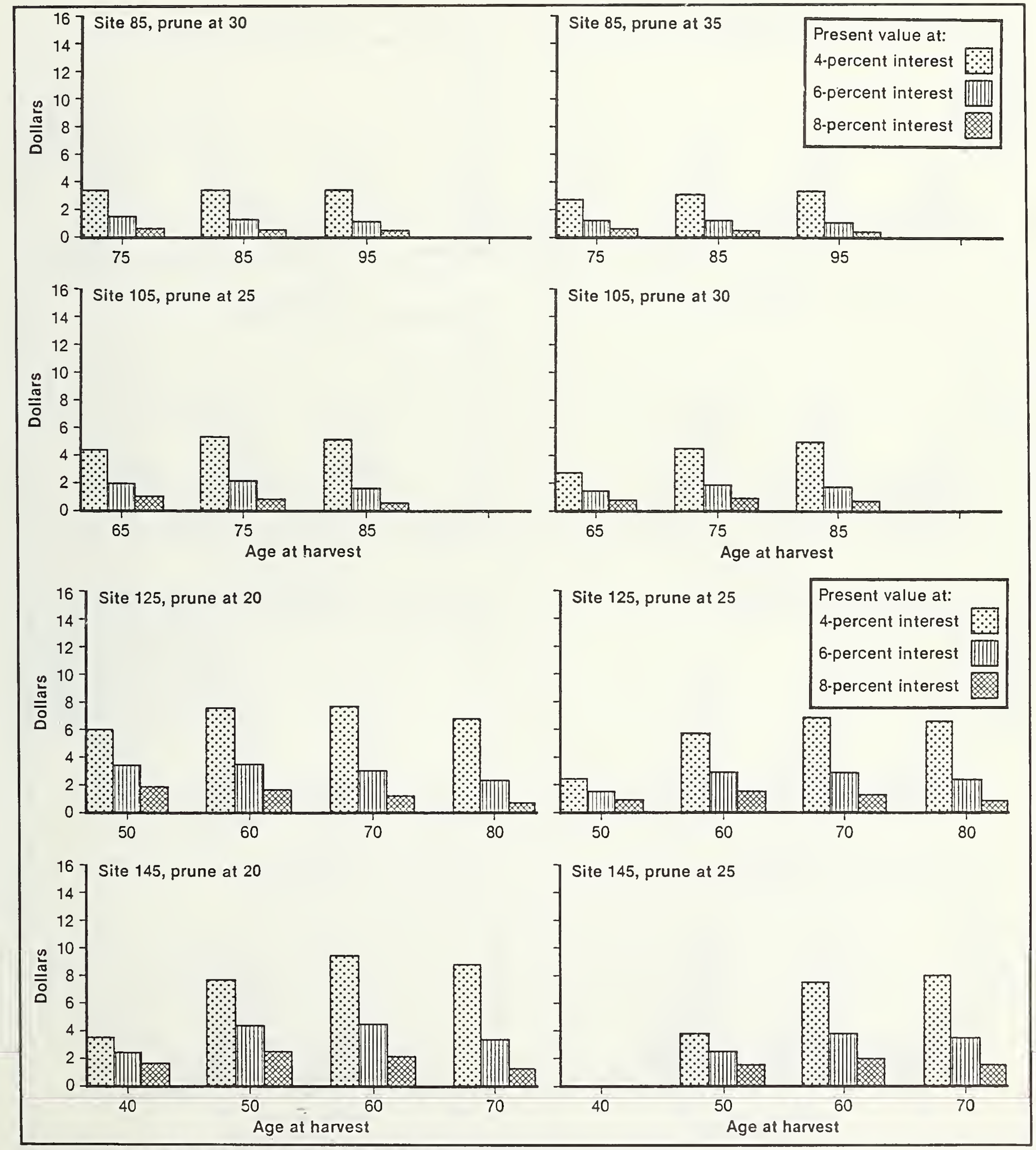

Figure 4—Increase in present value per tree from pruning unfertilized stands for veneer with the low price assumption.

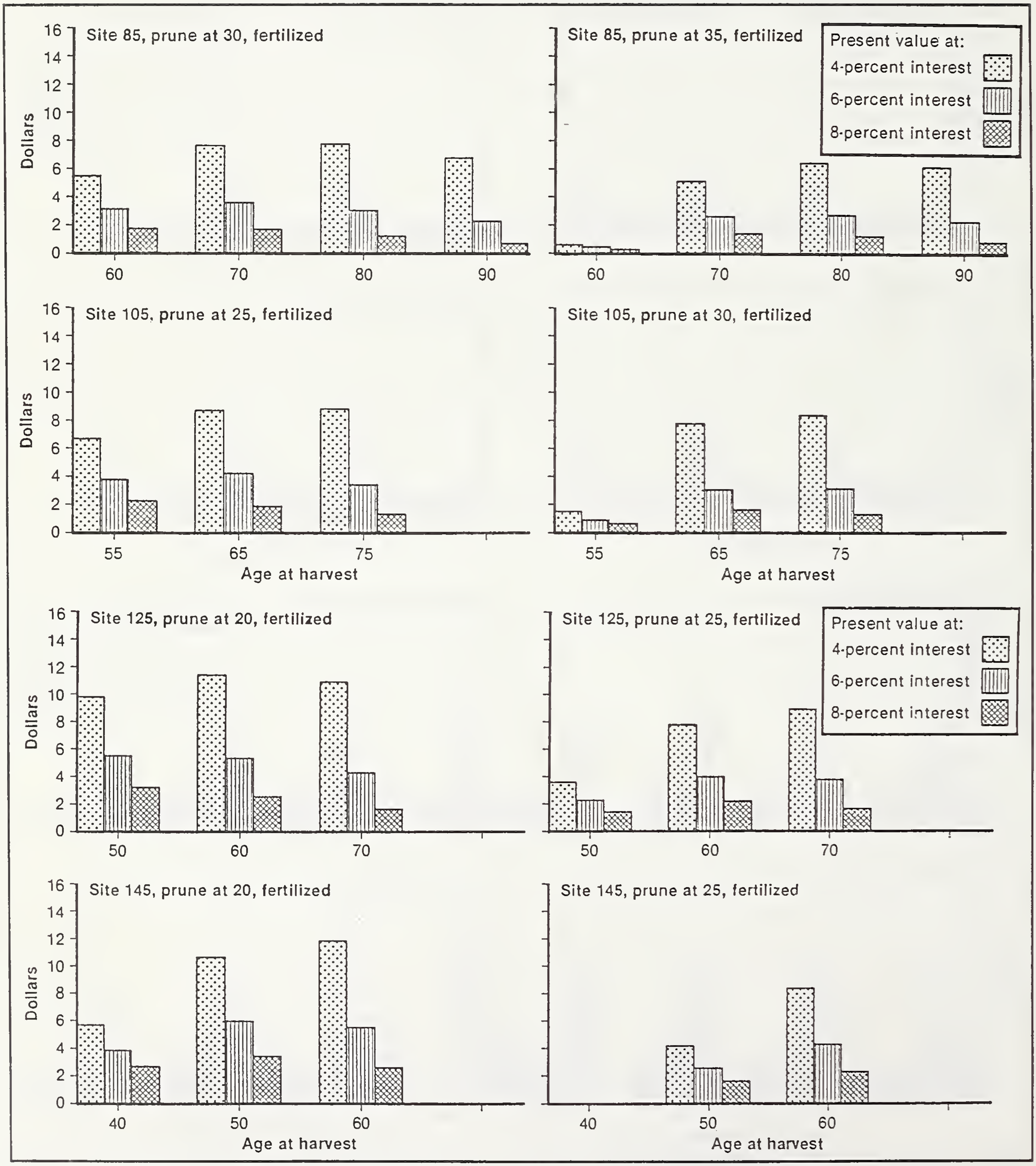

Figure 5—Increase in present value per tree from pruning fertilized stands for lumber with the high price assumption.

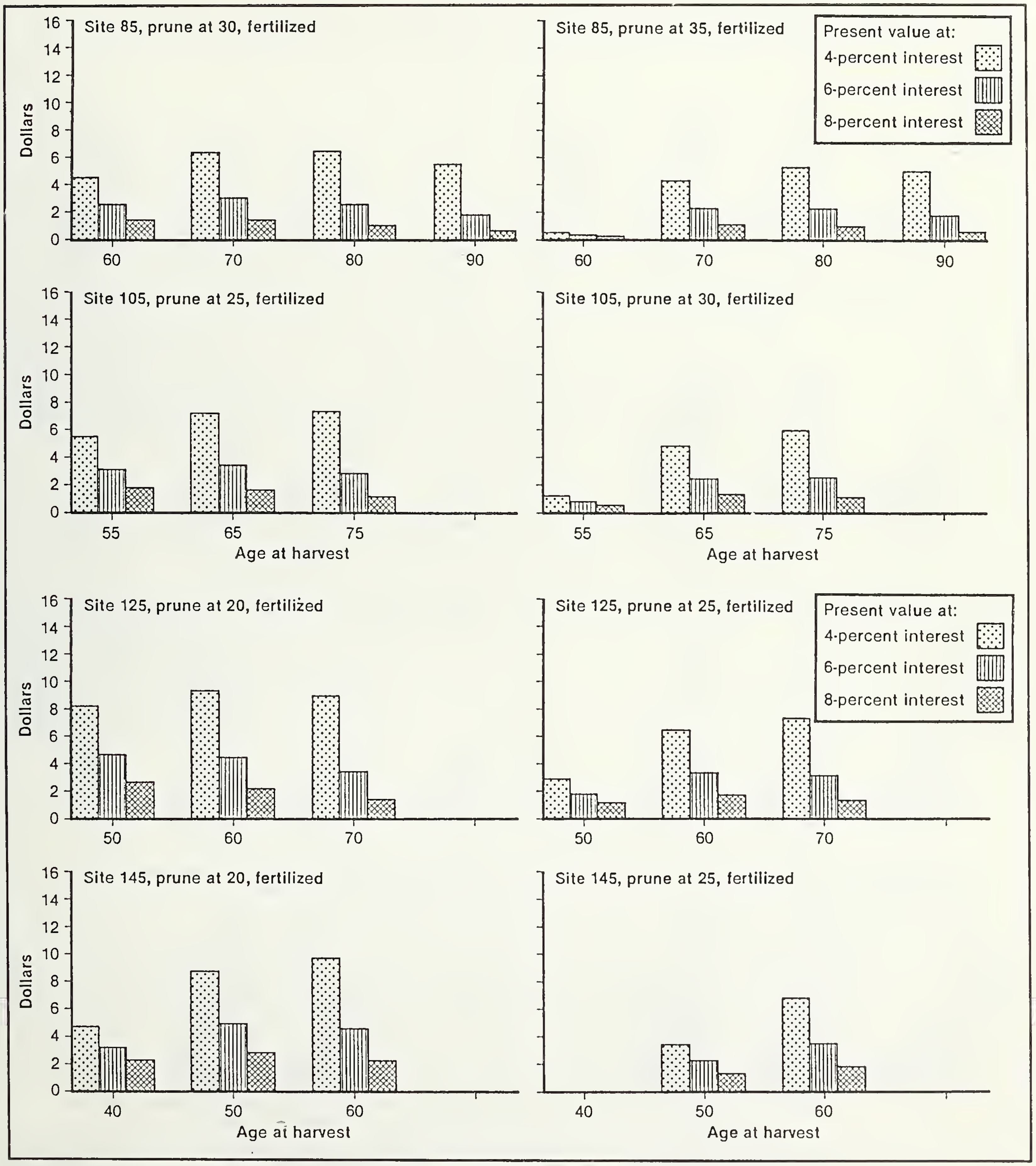

Figure 6—Increase in present value per tree from pruning fertilized stands for lumber with the low price assumption.

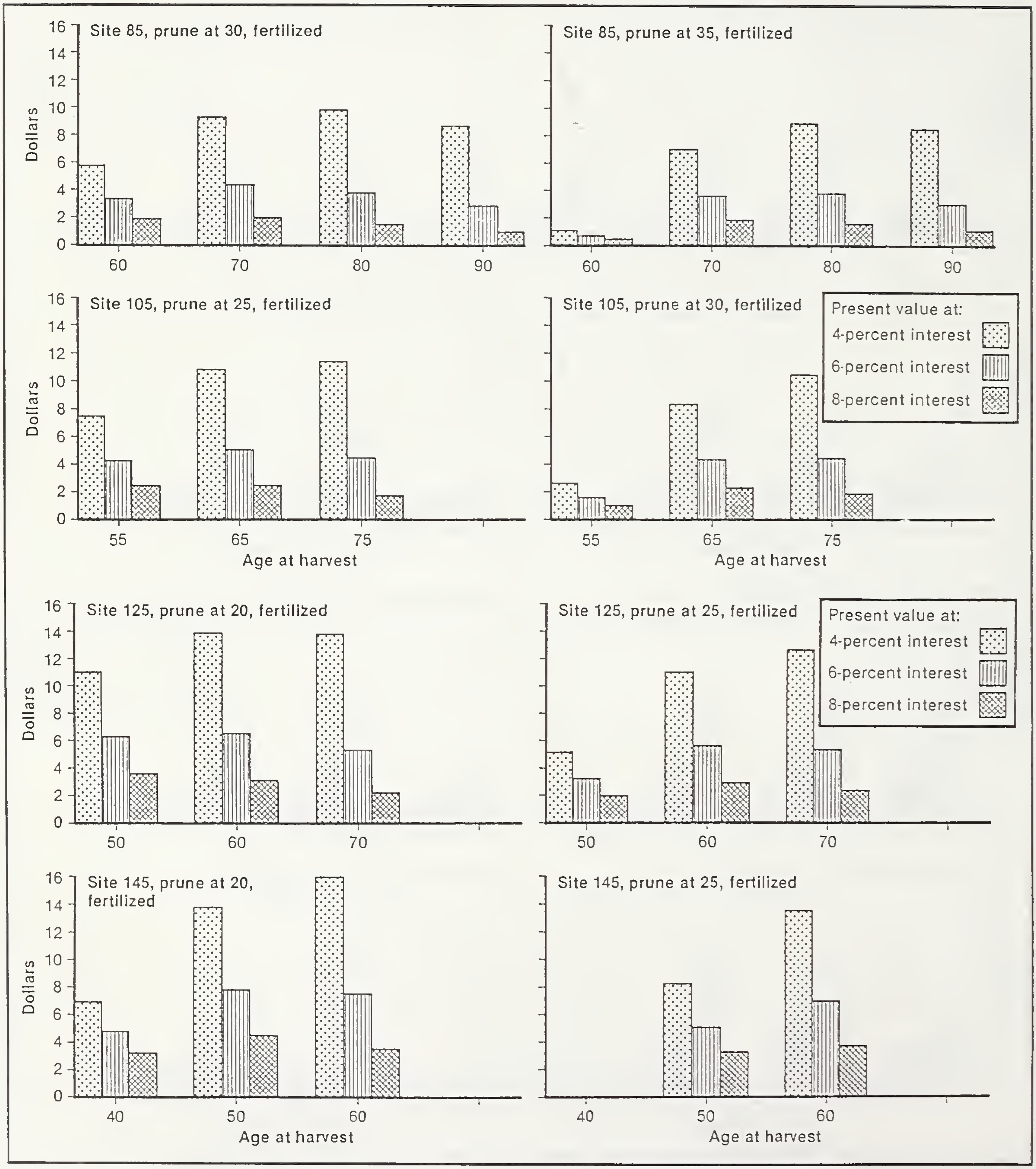

Figure 7—Increase in present value per tree from pruning fertilized stands for veneer with the high price assumption.

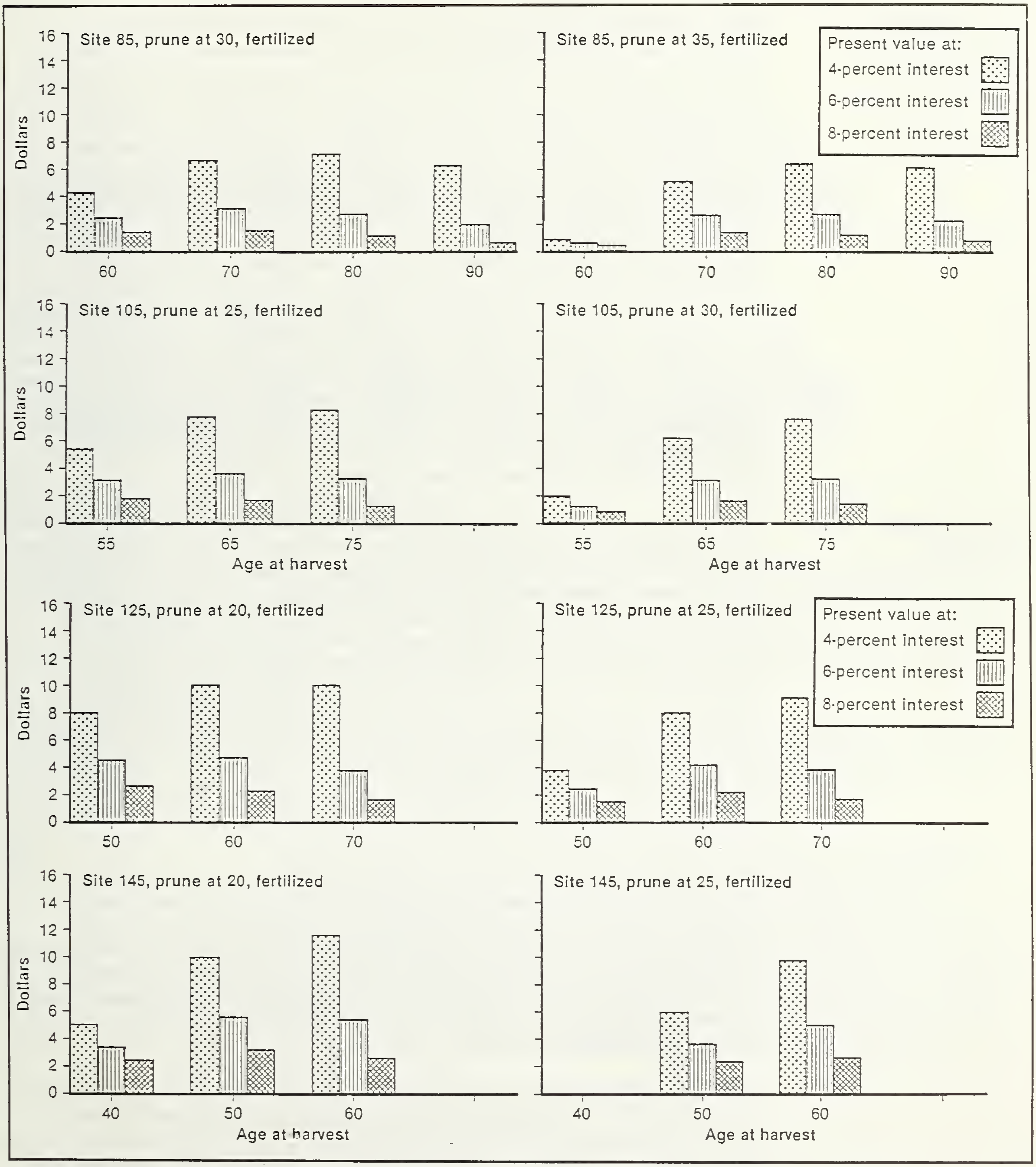

Figure 8—Increase in present value per tree from pruning fertilized stands for veneer with the low price assumption.

Comparisons

Age at Pruning

Figure 9 shows how the present value of pruning for the unfertilized regimes is affected by the age at pruning. The present value for later pruning is compared with the present value for the earlier pruning. The earlier age at pruning was selected as the first age (of ages ending in zero or five) when trees could be pruned to 18 feet without removing more than one-third of the live crown. Using data supplied from Reukema and Smith (1987), we estimated that the trees to be pruned must be a minimum of 43 feet tall to meet this criterion. The later age at pruning was 5 years later than the earlier age at pruning. These comparisons are between the regimes with the harvest age that gives the highest present value from pruning for each age at pruning. The results show that, in every case analyzed, the present value from pruning is higher for pruning at the earliest possible time. Although a comparable set of graphs for fertilized stands is not shown, the same conclusion applies to those regimes as well. For a specified harvest age, however, it will sometimes be better to delay pruning. For example, with a harvest age that is older than the one that gives the highest return from pruning, it may be better to delay pruning to reduce the number of years that the returns from pruning are delayed. The conclusion about pruning at the earliest possible time could be altered by the costs of pruning only if it cost more to prune at the earlier time. A practical consideration that is not accounted for in this analysis is whether or not the ability of the forester to select crop trees for pruning is significantly affected by the 5-year difference in the age at time of pruning.

Interval Between Pruning And Harvest

The effect of the interval between pruning and harvest on the return from pruning can be seen in figures 1-8. For a particular situation and age at time of pruning, each graph shows the present value from pruning for a range of harvest ages. These comparisons typically show a reduced number of pruned trees for the longer rotations because the number of trees that can be carried to rotation diminishes with increasing age at harvest. This means that, although longer rotations may have a higher return from pruning per tree, they may also have a lower return from pruning per acre. We suggest, however, that the per-tree figure is the more relevant comparison for two reasons. First, the cost of pruning is more closely related to the number of trees pruned than to the number of acres pruned. If costs are directly related to the number of trees pruned, then the present value per tree minus the cost of pruning per tree is a valid comparison. Second, a shortage of acres to prune in the future is unlikely, and the landowner can prune as many acres as needed to get the volume of pruned trees desired.

What conclusions can be drawn from these comparisons of age at harvest? Many of these comparisons show that there is a point beyond which return from pruning declines as the age at harvest is increased because the discounting of returns overtakes the rate of increase in value and causes the present value to decrease. This point occurs at an earlier age for higher interest rates. For example, the "Site 145, prune at 20" regime in figure 1 shows that at 4-percent interest this decrease occurs between harvest ages 60 and 70; at 6- or 8-percent interest, this decrease occurs between harvest ages 50 and 60.

An analysis of the results for each situation and age at pruning showed the following: At 4-percent interest, the interval after pruning that gave the highest present value from pruning was usually 40, 45, or 50 years; at 8-percent, the interval was usually 30, 35, or 40 years. The shorter intervals are associated with higher sites and fertilized stands where the rate of growth of clear wood is more rapid. At 6- and 8-percent interest rates for regimes with delayed pruning, the interval between pruning and

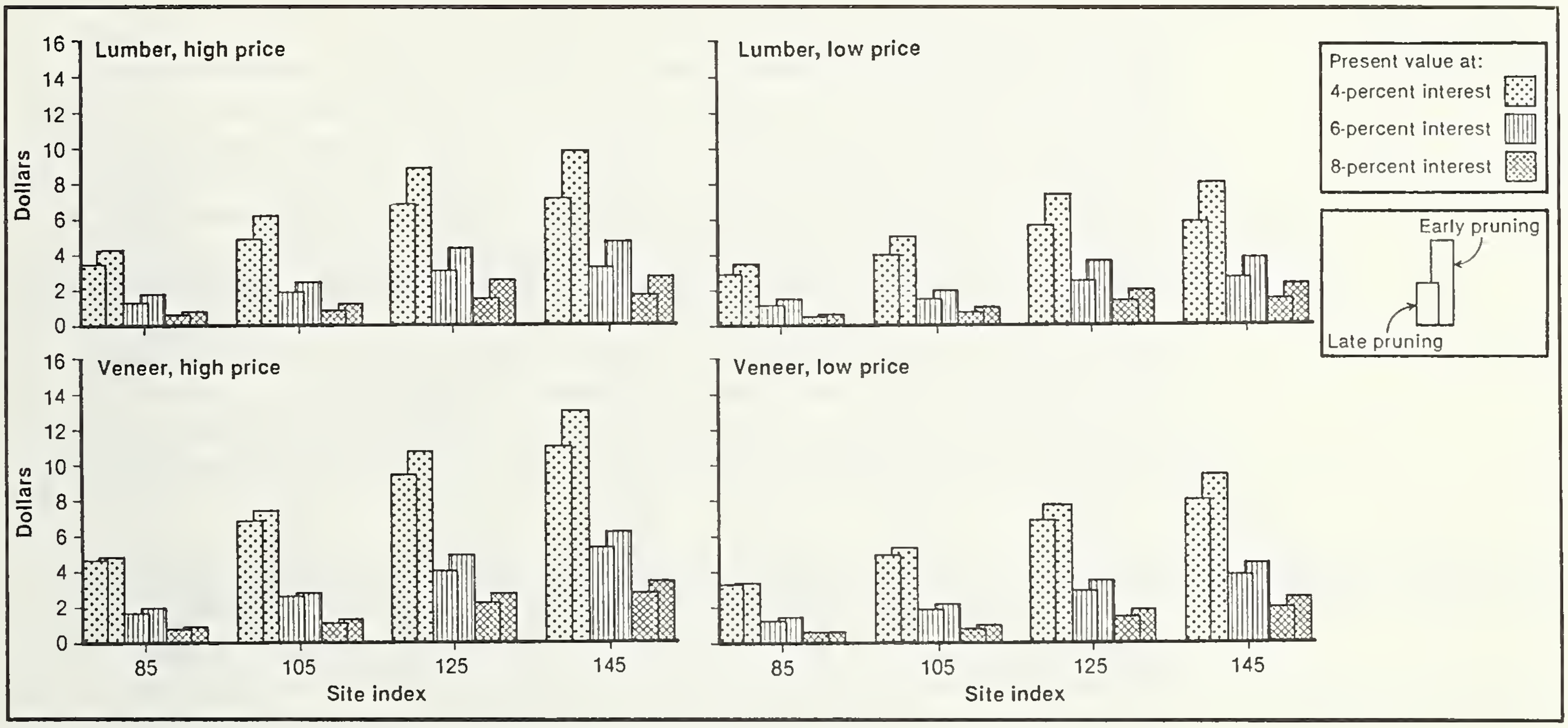

Figure 9—Comparison of increase in present value per tree from early and late pruning of unfertilized stands for lumber and veneer.

harvest that has highest present value increased by 5 years in most cases. The results with the 4-percent interest rate are mixed for regimes where pruning is delayed; about half show a higher value for a longer interval between pruning and harvest, and half show a lower value for a longer interval. This results from rounding and indicates that with a 4-percent interest rate, no significant effect on optimal time after pruning results from delaying the pruning.

The time after pruning that gives the highest return from pruning cannot be interpreted as the optimal age to harvest the stand. The optimal harvest age with pruning must be determined by a more complicated analysis because the harvest age affects the return from the whole management regime.

Site

The effect of site on the return from pruning can be seen in figure 9. Each graph in figure 9 shows the return from pruning for a range of sites. The effect of site index can be seen in a particular product-price-interest rate combination across sites. The general result is that the return from pruning is about twice as much on site index 145 as on site 85. The returns on sites 105 and 125 fall between. It should be obvious that investments in pruning will be most favorable on sites where the rate of growth of clear wood is highest as long as the rate of growth is not so rapid that it causes a decrease in quality. This relative difference will increase when the user subtracts the pruning cost from the present value of pruning to get the present net value of pruning.

Fertilization

Like the effect of site, the effect of fertilization should be obvious. Figure 10 shows the effect of fertilization on the present value of pruning. The regimes with fertilization are based on the regimes with repeated fertilizations in the DFSIM yield tables (Curtis and others 1982). The number of fertilizations for each site in the yield tables is three, but because they start at different ages on different sites, the number of fertilizations in the pruning evaluations varies by site and the harvest age. In some cases the harvest is taken at a time that would have made the preceding fertilization infeasible because of the short time between the fertilization and harvest. In those cases, however, the effect of the fertilization is minimal so the result is not much different than if that fertilization had been omitted. Figure 10 clearly demonstrates the interaction effect of fertilization and pruning; pruning a stand that will be fertilized yields a significantly higher return from pruning than if the stand is not fertilized. This relative difference will increase when the cost of pruning is subtracted from the present value of pruning to get the present net value of pruning.

Wood Product Prices

Figure 11 shows the present value from pruning with the low price assumption compared with the present value from pruning with the high price assumption. Under both price assumptions, the return from pruning is somewhat higher for veneer. Concluding, however, that whether the pruned logs are used for lumber or veneer makes little difference is not necessarily correct. The gross product value of both pruned and unpruned logs happens to be lower for veneer than for lumber for all regimes under both price assumptions. Manufacturing costs must be considered before the net value of pruned and unpruned logs in both lumber and veneer can be determined. This analysis allows us to conclude only that if the butt logs will be made into a particular product, the increase in present value will be as shown for the specified conditions.

The difference in return from pruning between the low and high price assumptions results solely from the difference in price between the highest grades and the lower grades of products. If prices were increased by increasing the price for all grades by a constant amount, the return from pruning would not be affected. Projections of wood product prices must be regarded as uncertain guides to future prices. Projections of the differences in prices between grades must be regarded as even more uncertain. Because of the uncertainty, we used both current and “best guess” future prices in the analysis. Because of this uncertainty and the fact that the return from pruning is quite sensitive to the difference in prices between grades, many users of PRUNE-SIM will want to do additional sensitivity analyses with prices.

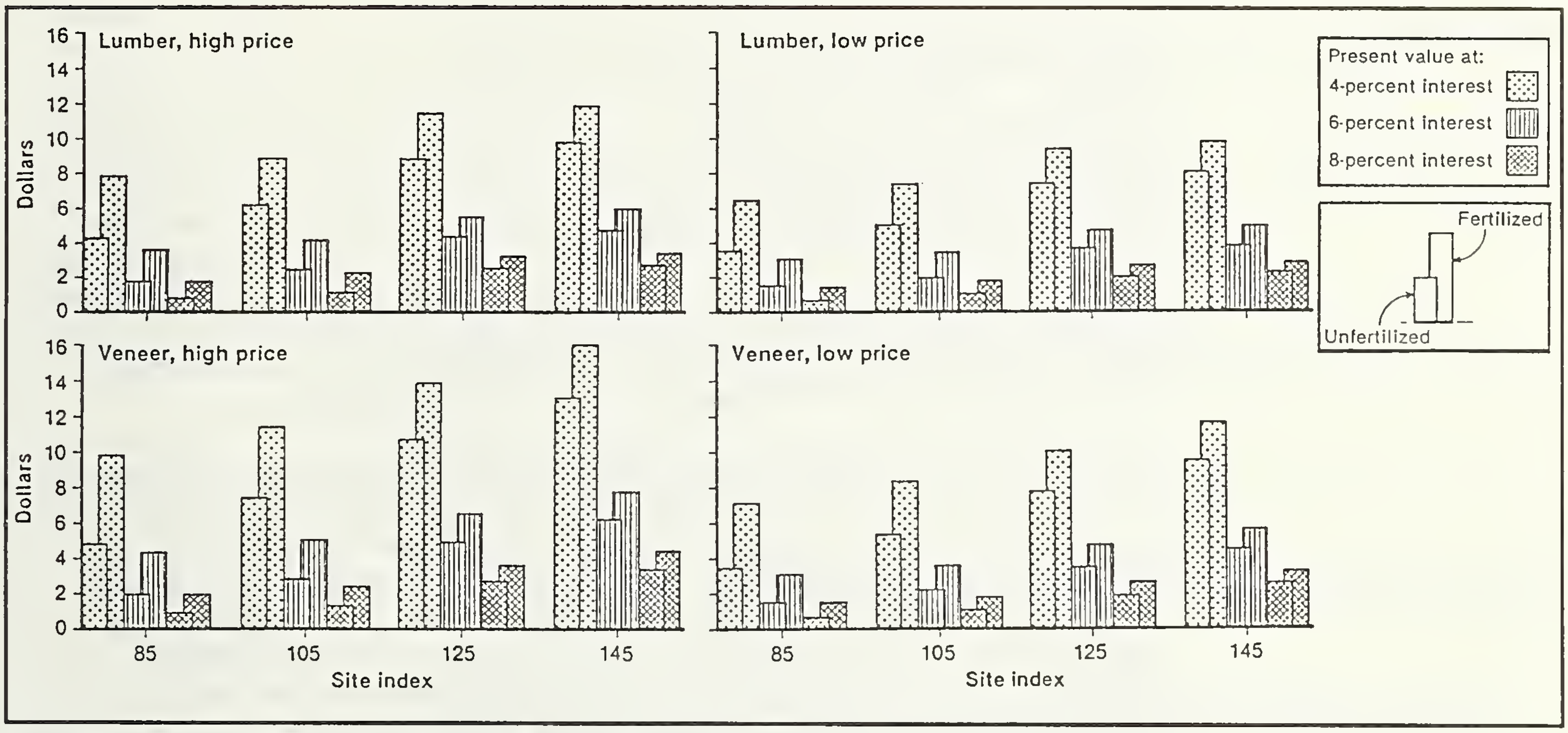

Figure 10—Comparison of increase in present value from pruning of unfertilized and fertilized stands for lumber and veneer.

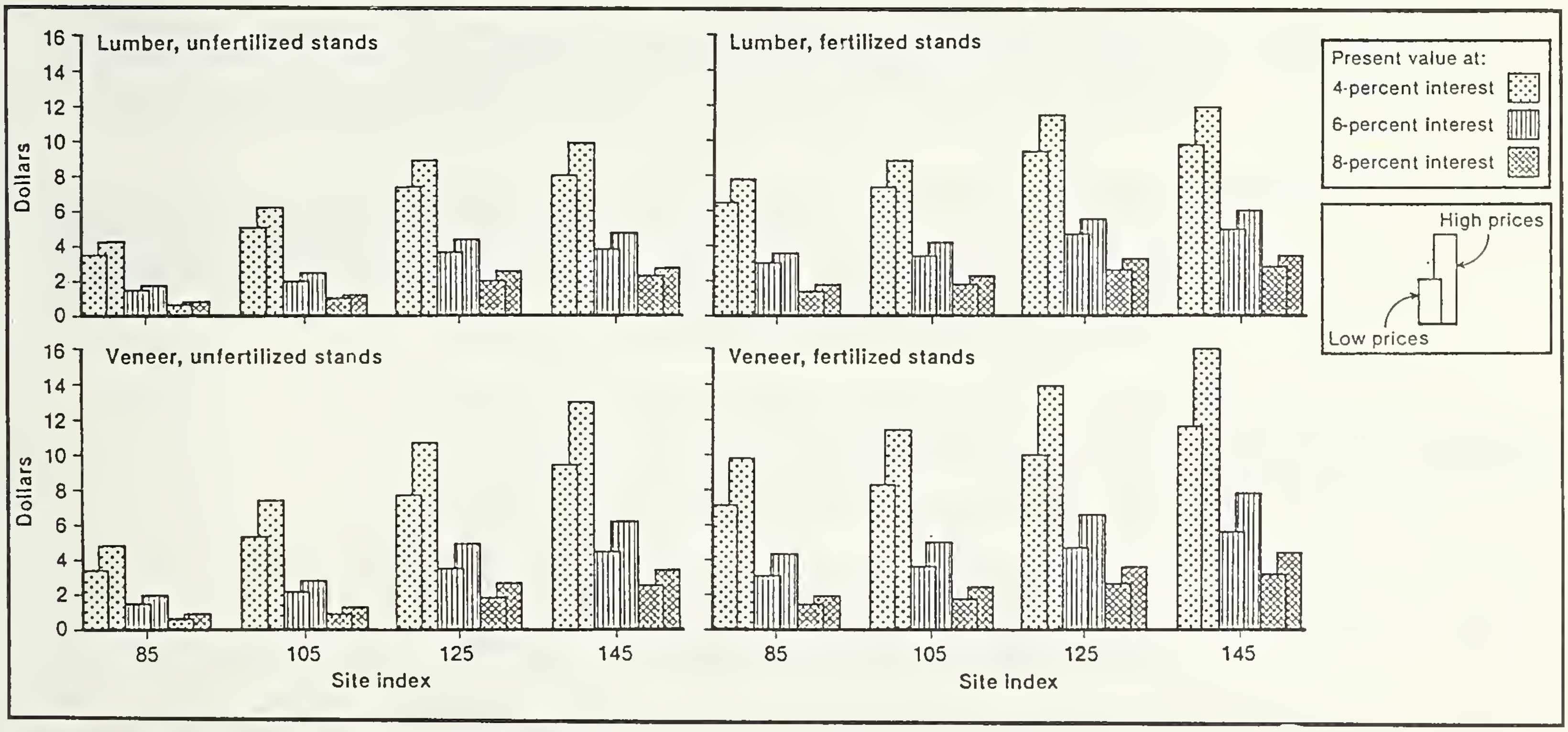

Figure 11—Comparison of increase in present value from pruning of unfertilized and fertilized stands for lumber and veneer with low and high prices.

Conclusions

What can we say about the question, "Will the increase in value justify the investment in pruning?" The results clearly show that the expected increase in present value from pruning is often more than $3 per tree. At a 4-percent interest rate, almost all regimes in figures 9-11 exceed $3 per tree. At a 6-percent interest rate, some of the regimes exceed $3 per tree; at an 8-percent interest rate, only one regime exceeds $3 per tree. Apparently, even with 1986 prices, sometimes pruning will return more than $3 per tree with an interest rate of 4 or 6 percent. With an increase in price premium for high grade products, the number of situations that will return $3 per tree increases rapidly. With wages, benefits, and equipment costs of $15 per hour, the cost of pruning will be $3 per tree at a rate of five trees per hour. Our limited information indicates that in many situations a rate of five trees per hour could easily be achieved.

What about the other costs of pruning not considered in this analysis? One is the cost of keeping records on the location of pruned stands and perhaps pruned trees in those stands. Such records are essential to ensure that the pruned trees are not inadvertently harvested prematurely. Also, the seller of stumpage must be able to convince potential buyers that the clear wood will translate into increased product value in the mill. Where competition for stumpage between mills that have the capability to effectively use this clear material exists, proper appraisal and documentation should ensure that the stumpage seller gets a large part of the increase in value. In areas with limited competition or no mills that can effectively use this clear material, the seller may not be able to get the increased value.

One potential benefit from pruning was not considered in this analysis. Where higher planting densities are predicated on the need for reducing the size of limbs on the lower portion of the bole, that need is eliminated with pruning. This may result in a lower planting cost that can be attributed to the decision to prune.

In spite of the uncertainties about the assumptions and relations used in this analysis, we believe that the analysis represents the best available information and provides a reasonable basis for forest managers to draw some conclusions about the financial feasibility of pruning coast Douglas-fir.

Metric Equivalents

1 inch = 2.54 centimeters

1 foot = 0.305 meter

1 cubic foot = 0.028 cubic meter

1 acre = 0.4047 hectare

1 pound = 0.45 kilogram

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